Sounding Rocket Working Group
June 16, 2004

NASA Sounding Rocket Operations Contract
(NSROC)

NASA Goddard Space Flight Center

SRWG Agenda - NSROC

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Analytical Capabilities Enhancements	
Summary	

Programmatic

- Contract Status
  - Approaching mid-point of contract year 6
  - 163 FTE's
  - 4 part time
- Subcontract Status
  - No significant issues
  - Eliminated SVC support in Feb. '04
  - Minimized Aerojet support through Oct. '04
- Outreach
  - Continued participation and support of the intern program and student missions.
  - Currently 9 co-op/intern students on staff
- New Business
  - Continue marketing Wallops' assets. Several new missions and fabrication work planned for FY05.
  - Supporting various NASA centers with Code T proposals and activities

Programmatic

- Last Year's Accomplishments
  - Finalist for Contractor Excellence Award in 2004
    - Will submit application for 2005
  - Achieved registration to the new ISO 9000-2000 standards
  - Demonstrated New Technical Capabilities
  - Very Good PEB Scores

Programmatic

- Challenges
  - Implement new technology
    - Attitude Control Systems
    - New Vehicle Configurations
  - Mission scheduling
    - Advance planning
    - Staggered integrations
    - Reduce overtime requirements
  - Complex missions
    - CASCADES
  - Budget

Findings

- Sounding Rocket Program Handbook
  - Latest version available at NSROC.com
  - Current revision May 2003 – minor revisions since 2/01
  - New revision, including up to date ACS info, released by end of year
- Other findings addressed in other portions of presentation

Missions Flown Since Last SRWG Meeting

- 36.210/Stern
  - Re-fly of 36.201 telescope
  - Flown 1/16/04 from WSMR
  - All vehicle and sub-systems performed nominally
  - Experiment results - waiting for PI input
- 35.035/Kintner
  - SERSIO – ionospheric study - similar to 40.014
  - Flown 1/22/04 from Norway
  - All vehicle and sub-systems performed nominally with exception of ACS
  - Little or no useful experiment data
- 12.054/Krause
  - Non-spinning test flight of NIACS and ST-5000
  - Flown 4/13/04 from WSMR
  - All vehicle and sub-systems performed nominally
  - Both NIACS and ST-5000 performed exceptionally

Missions Flown Since Last SRWG Meeting (cont.)

- ScramJet
  - Follow on flight of hypersonic engine test bed
  - Flown 4/16/04 from WFF
  - NSROC supported telemetry design, fabrication and test
  - Excellent results
- 36.209/Green
  - Re-fly of 36.197 telescope with mechanical mod to reduce imbalance
  - Flown 6/1/04 from WSMR
  - All vehicle and sub-systems performed nominally with exception of command uplink
    - AIB assigned to investigate
  - Good experiment data obtained
- 30.060/Parrott
  - High school student payload (4 schools)
  - Flown 6/9/04 from WFF
  - All vehicle and sub-systems performed nominally
  - Good experiment data obtained

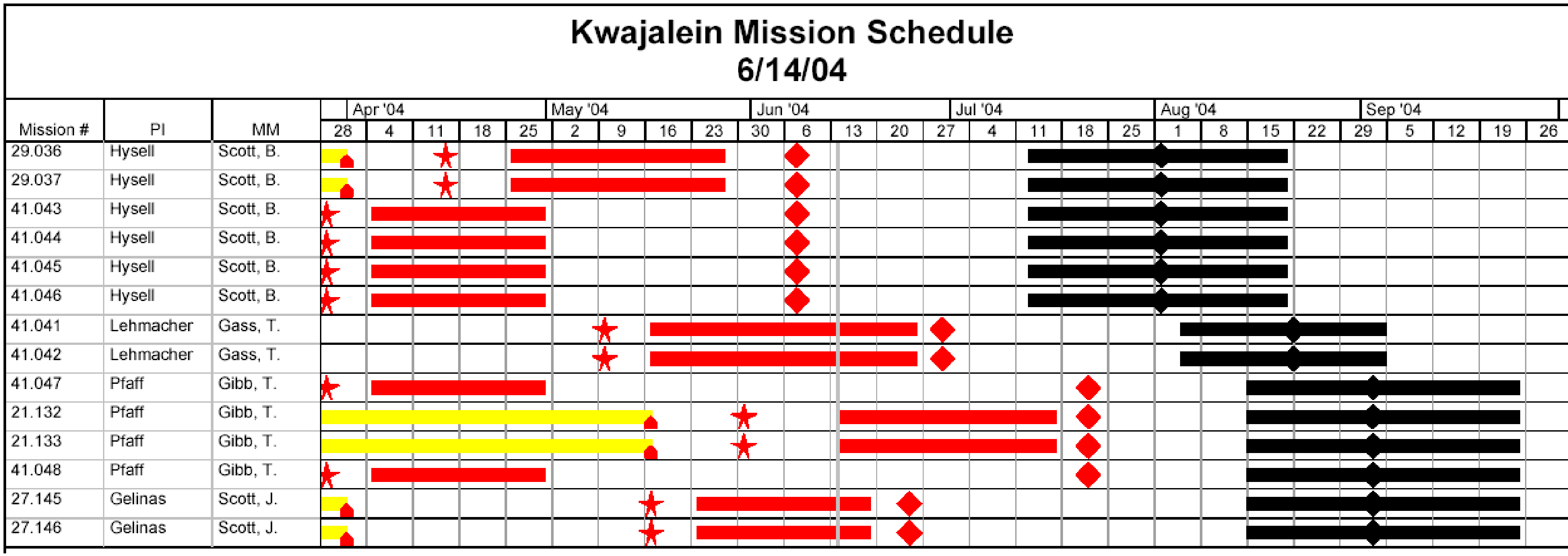
Missions Scheduled Prior to Next SRWG Meeting

- Winstead/ARAV
  - Two targets (TerrierMk70/Oriole/Star-20)
  - Launch from PMRF mid-July
  - NSROC provides vehicle systems and I&T support
- Hysell/Lehmacher/Pfaff/Gelinas
  - 8 instrumented rockets – 6 with NMACS
  - 6 TMA rockets
  - Scheduled for launch from Kwajalein in August and September
- 12.056/Krause
  - Spinning test of NIACS
  - Launch from WSMR 8/10/04
- 36.216/Martin
  - Re-fly of 36.204
  - Launch from WSMR 10/12/04

Missions Scheduled Prior to Next SRWG Meeting

- 36.217/Woods
  - Re-fly of 36.205
  - Launch from WSMR 10/14/04
- 30.056/Hall
  - Va. Tech. student payload
  - Launch from WFF 11/15/04
- 36.203/Rabin
  - New SPARCS payload similar to SERTS
  - Launch from WSMR 11/17/04
- 12.055/Krause
  - Talos/Oriole test round
  - Launch from WFF 11/29/04

Kwajalein Mission Status



2004 Events of Note

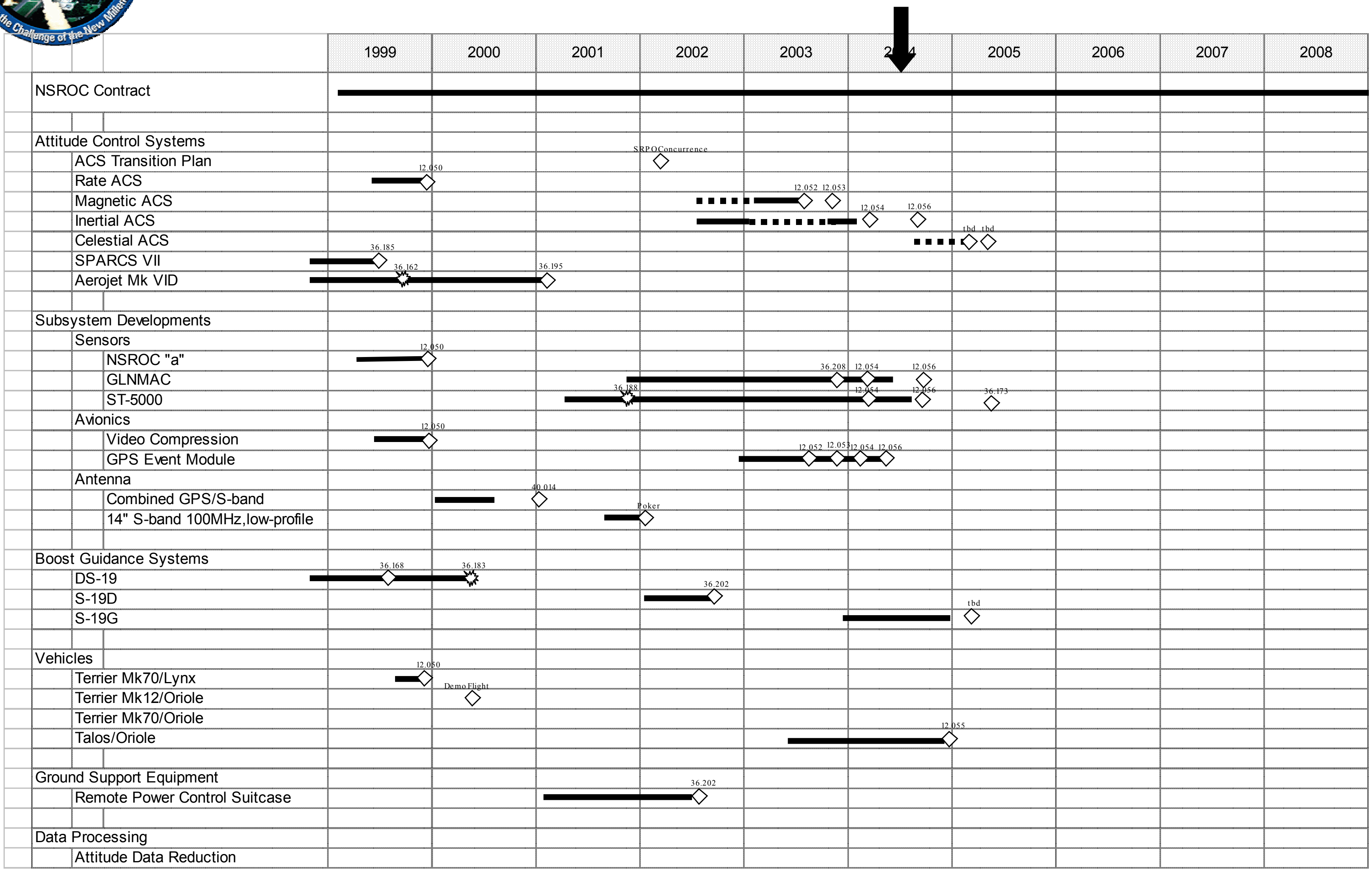
Technology Thrusts

12.054 Inertial ACS/ST-5k Mission Summary

12.055 Talos/Oriole Vehicle Demonstration Mission

35.035 Kintner Mission Failure

Technology Thrusts



12.054 Mission Summary

- NSROC Inertial Attitude Control System (NIACS) Technology Demonstration Mission
- All Mission Objectives Achieved:
  - Aligned to zenith with ST-5k and optical camera observing
  - Perform a series of 5 inertial maneuvers
  - Stopped the payload after each maneuver and allow the ST-5k to take a snapshot and compute an attitude solution
  - Determine inertial pointing accuracies between each position and overall accuracy (from start to finish of inertial maneuvers)
  - Attitude pointing verifications came from the GLNMAC, ST-5k and Optical Camera

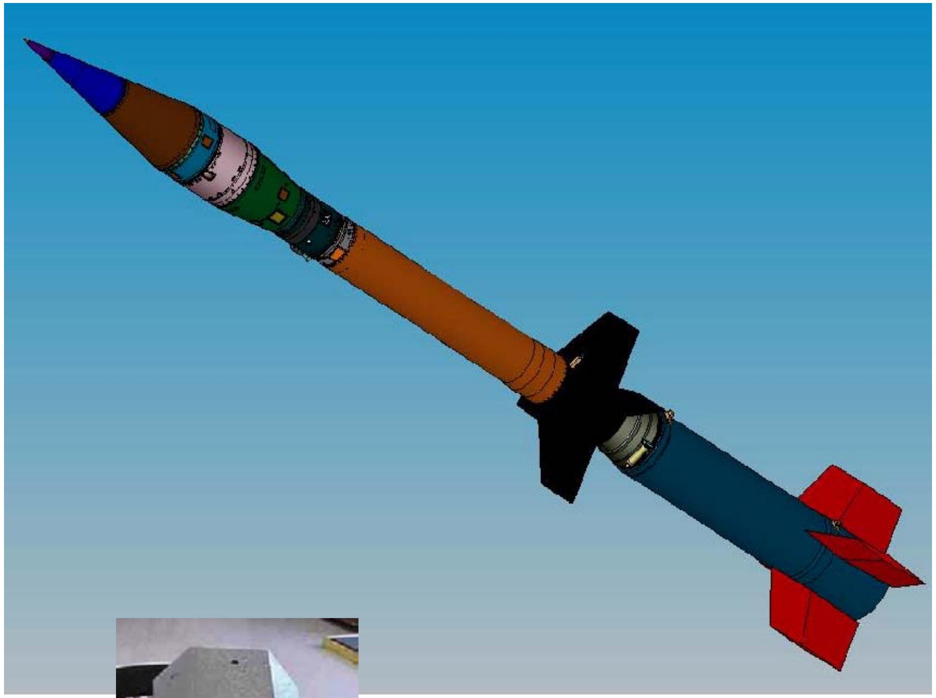
- Vibration sensor suite collected flight dynamics for test standards comparisons and analyses

- Iridium Piggyback maintained lock and communicated with the Iridium satellite constellation

	Absolute Pointing Accuracy (deg)	System Stability (deg)
Target #1	0.029	
Target #2	0.046	
Target #3	0.034	
Target #4	0.040	
Target #5	0.038	
#1 - #5		0.90

12.055 Talos/Oriole Demonstration Launch

- Primary Objective: Flight demonstrate the Talos/Oriole vehicle. This mission is a precursor to the JPL NMP ST-9 missions.
- Suite of dynamic sensors are included to assess flight dynamics and vehicle environments for new NSRP vehicle
- Piggyback payloads:
  - Ames Waveriders
    - 4 ft & 6 ft (length) Hypersonic Waveriders
    - 14” diameter SCRAMP



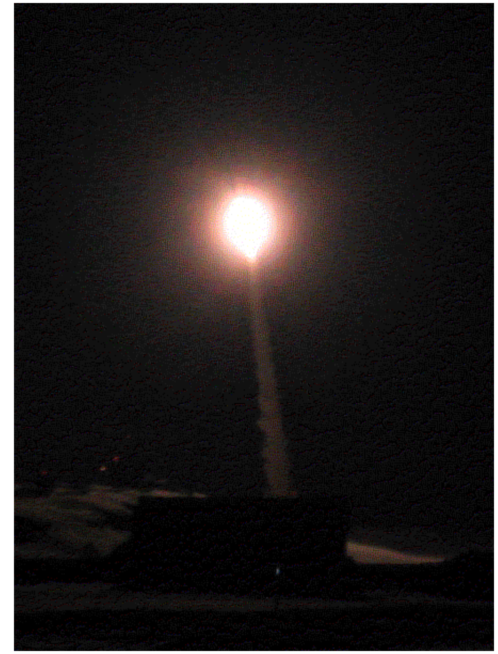
35.035 Mission Failure

- Launch Date: January 22, 2004
- Location: Svalrak, NOR
- PI: Dr. Paul Kintner, Cornell University

- Mission Anomaly: The payload opened into ~60° ½ cone angle due to NSROC Magnetic ACS failure.

- Root Cause: The polarity of the lateral reaction nozzles was reversed. Incomplete preflight checks to verify system preparedness.

- NSROC AIB established
  - D. Krause, Chair
  - Dr. K. Lynch
  - S. Powell
  - M. Peterson
  - M. Simko
  - F. Lau
  - S. Elborn
  - K. DiGiulian
  - V. Gsell



35.035 Mission Failure

- NSROC AIB established 4 major Action Items

AI 1. Identify a cognizant NMACS Engineer for system ownership

AI 2. Establish a NMACS System Level Process Flow

- -Including the development and usage of hardware checkout procedures/documentation
- -Develop detailed procedures for system checkout
    - Including a phasing test for verifying polarity, etc. with flight sensors and flight software

AI 3. Enhance the NMACS engineer's 'system design document' to include

- -Process flow & test plan
- -Configuration control
    - Airbearing and flight
    - Specifically noting differences (and understanding them)
- -Software configuration control

AI 4. Enhance the NMACS tech's logbook to include, at a minimum:

- -Noting <u>all</u> NMACS hardware activities (pneumatics, interface tests, pressure tests, hardware mods/deltas, etc.)
- -Processing documents/ test plans

NSROC Electrical Engineering

Program Enhancements

GPS Event Module (GEM)

System Capabilities

- 15 Programmable Events with 12 Event Input Backup’s
- Upleg, Apogee and Downleg Control
- 1 KM or Better Altitude Accuracy
- Flight proven micro-controller and driver electronics used

System Status

- Unit 1 Incorporated in 12.052 and successfully flown on August 1st
- Unit 2 Incorporated in 12.053 and successfully flown on October 24th
- Unit 3 incorporated in 12.054 and successfully flown on April
- The GEM is now considered fully qualified
- Unit 3 will fly again in 12.056 in August, ’04

Program Enhancements

GPS Event Module (GEM)

Issues/Concerns

- Loss of GPS lock at T-0 on high acceleration/jerk missions
- GPS jamming & spoofing at WSMR, PFRR & possibly other sites
- Users will require GEM when not really needed, increasing mission costs, testing complexity, and increasing mission risk

Additional Mission Requirements When GEM Incorporated

- An additional All-Fire sequence test for each phase of testing
- A flight trajectory profile will have to be programmed into GPS simulator for each mission
- Optimally will require a dedicated portable GPS simulator for GEM checkout and sequence testing
- Additional mission effort for determining optimum MFT backup event times. For missions with numerous closely spaced in-flight events this effort will be involved and much more complicated.

Program Enhancements

12.052 GPS Event Module (GEM) Flight Data Results

EVENT	GPS Driven			MFT(B/U)	Latency of GPS Driven Output--Error	
	Time	Altitude	Vertical Velocity	Time	Delta Altitude	Delta Time
GEM Event 1 (50 km)	48.582	≈ **50.312 km**		58.202	≈ 312 meters	0.18
Up Leg	48.6	50.343 km	1697.9 m/sec			
GEM Event 2 (60 km)	54.582	≈ **60.323 km**		64.202	≈ 323 meters	0.2
Up Leg	54.6	60.353 km	1640.3 m/sec			
GEM Event 3 (70 km)	60.782	≈ **70.306 km**		75.202	≈ 306 meters	0.19
Up Leg	60.8	70.334 km	1581.7 m/sec			
GEM Event 4 (80 km)	67.282	≈ **80.378 km**		85.223	≈ 378 meters	0.25
Up Leg	67.3	80.405 km	1519.1 m/sec			
GEM Event 5 (90 km)	73.982	≈ **90.342 km**		95.223	≈ 342 meters	0.23
Up Leg	74	90.368 km	1457.5 m/sec			
GEM Event 6 (100 km)	80.982	≈ **100.309 km**		105.223	≈ 309 meters	0.22
Up Leg	81	100.334 km	1391.3 m/sec			
GEM Event 7 (110 km)	88.383	≈ **110.344 km**		120.223	≈ 344 meters	0.26
Up Leg	88.4	110.367 km	1324.4 m/sec			
GEM Event 8 Apogee	231.984	**204.529 km**		235.224	≈ 0 meters	≈0.30
(204.7529 km)@ +231.7	232	204.529 km	-2.498 m/sec			
GEM Event 9 (120 km)	367.585	≈ **119.747 km**		370.245	≈ 253 meters	0.2
Down Leg	367.6	119.728 km	-1252.7 m/s			
GEM Event 10 (110 km)	375.386	≈ **109.690 km**		378.246	≈ 310 meters	0.23
Down Leg	375.4	109.672 km	-1325.2 m/s			
GEM Event 11 (100 km)	382.786	≈ **99.622 km**		385.246	≈ 378 meters	0.27
Down Leg	382.8	99.602 km	-1395.8 m/s			
GEM Event 12 (90 km)	389.786	≈ **89.622 km**		392.246	≈ 378 meters	0.26
Down Leg	389.8	89.602 km	-1461.0 m/s			
GEM Event 13 (80 km)	396.486	≈ **79.617 km**		N/A	≈ 383 meters	0.25
Down Leg	396.5	79.596 km	-1525.4 m/s			
GEM Event 14 (70 km)	402.886	≈ **69.665 km**		N/A	≈ 335 meters	0.21
Down Leg	402.9	69.643 km	-1585.0 m/s			
GEM Event 15 (60 km)	409.086	≈ **59.662 km**		N/A	≈ 338 meters	0.21
Down Leg	409.1	59.639 km	-1639.6 m/s			

Program Enhancements

12.053 GPS Event Module (GEM) Flight Data Results

EVENT	GPS Driven			MFT(B/U)	Latency of GPS Driven Output--Error	
	Time	Altitude	Vertical Velocity	Time	Delta Altitude	Delta Time
GEM Event 1 (35 km)	81.263	≈ **88.33 km***		43.23	≈ 53.3 km*	47.4*
Up Leg	81.3	88.372 km	+1124 m/sec			
GEM Event 2 (67.3 km)	81.263	≈ **88.33 km***		66.23	≈ 16 km*	14.2*
Up Leg	81.3	88.372 km	+1124 m/sec			
GEM Event 3 (100.7 km)	92.983	≈ **100.896 km**		94.23	≈ 196 meters	0.19
Up Leg	93	100.913 km	+1016 m/sec			
GEM Event 4 Apogee	202.48	≈ **156.213 km**		217.25	≈ 0 meters	≈0.30
(156.213 km) @ +202.2	202.5	156.213 km	0 m/sec			
GEM Event 5 (143 km)	255.68	≈ **142.892km**		302.25	≈ 108 meters	0.22
Down Leg	255.7	142.883 km	-496 m/sec			
GEM Event 6 (127.7 km)	280.68	≈ **127.552km**		320.25	≈ 148 meters	0.2
Down Leg	280.7	127.539 km	-725 m/sec			
GEM Event 7 (122.2 km)	116.68	≈ **122.343 km**		117.23	≈ 143 meters	0.18
Up Leg	116.7	122.360 km	+796 m/sec			
GEM Event 8 (141 km)	145.08	**141.128 km**		114.23	≈ 128 meters	0.24
Up Leg	145.1	141.140 km	+530 m/sec			
GEM Event 9 (70 km)	338.48	≈ **69.677km**		369.25	≈ 323 meters	0.25
Down Leg	338.5	69.649 km	-1270 m/s			
GEM Event 10 (20 km)	28.473	≈ **20.207 km**		30.23	≈ 207 meters	0.19
Up Leg	28.5	20.237 km	+1105 m/s			
GEM Event 11 (37.7 km)	362.08	≈ **37.440 km**		390.25	≈ 260 meters	0.19
Down Leg	362.1	37.409 km	-1405 m/s			
GEM Event 12 (105.5 km)	306.78	≈ **105.311 km**		341.25	≈ 189 meters	0.19
Down Leg	306.8	105.289 km	-972 m/s			
GEM Event 13 (200 km)	**	**	**	N/A	**	
Up Leg						
GEM Event 14 (200 km)	202.68	≈ **156.212km**		N/A	≈ 43.788 km***	
Down Leg	202.7	156.212 km	*** 0 m/s			
GEM Event 15 (20 km)	376.07	≈ **19.827 km**		N/A	≈ 173 meters	0.19
Down Leg	376.1	19.799 km	-900 m/s			

Notes: * Loss of GPS lock from altitude 30.160 km to 88.330 km on ascent.
** This altitude was not reached, so event never fired since it was an up-leg event
*** This altitude was not reached, so event fired at apogee, since it was a down-leg event.

Program Enhancements

12.054 GPS Event Module (GEM) Flight Data Results

EVENT	GPS Driven			MFT(B/U)	Latency of GPS Driven Output--Error	
	Time	Altitude	Vertical Velocity	Time	Delta Altitude	Delta Time
GEM Event 1 (50 km)	52.166	≈ **50.295 km**			≈ 295 meters	0.254
Up Leg	52.2	50.335km	1165.11 m/sec			
GEM Event 2 (60 km)	61.075	≈ **60.295 km**			≈ 295 meters	0.27
Up Leg	61.1	60.322 km	1078.94 m/sec			
GEM Event 3 (70 km)	70.675	≈ **70.215 km**			≈215 meters	0.217
Up Leg	70.7	70.239 km	987.01 m/sec			
GEM Event 4 (80 km)	81.373	≈ **80.236 km**			≈ 236 meters	0.266
Up Leg	81.4	80.405 km	885.57 m/sec			
GEM Event 5 (90 km)	93.369	≈ **90.174 km**			≈ 174 meters	0.226
Up Leg	93.4	90.368 km	771.01 m/sec			
GEM Event 6 (100 km)	107.562	≈ **100.164 km**			≈ 164 meters	0.258
Up Leg	107.	100.334 km	635.67 m/sec			
GEM Event 7 (110 km)	125.571	≈ **110.088 km**		132.4	≈88 meters	0.190
Up Leg	125.6	110.367 km	465.75 m/sec			
GEM Event 8 Apogee	175.284	**121.58 km**		181.7	≈ 0 meters	≈0.30
(121.58 km)@ +175.28	175.3	km	-3.96 m/sec			
GEM Event 9 (110 km)	224.674	≈ **109.917 km**		245.0	≈ 83 meters	0.17
Down Leg	224.7	119.728 km	-469.55 m/s			
GEM Event 10 (100 km)	242.784	≈ **99.865 km**		260.0	≈ 135 meters	0.211
Down Leg	242.8	109.672 km	-640.75 m/s			
GEM Event 11 (90 km)	256.976	≈ **89.813 km**		272.5	≈ 187 meters	0.241
Down Leg	257.0	99.602 km	-776.65 m/s			
GEM Event 12 (80 km)	268.972	≈ **79.822 km**		283.5	≈ 178 meters	0.200
Down Leg	269.0	89.602 km	-890.51 m/s			
GEM Event 13 (70 km)	279.663	≈ **69.760 km**		N/A	≈ 240 meters	0.242
Down Leg	279.7	79.596 km	-992.56 m/s			
GEM Event 14 (60 km)	289.263	≈ **59.795 km**		N/A	≈ 205 meters	0.189
Down Leg	289.3	69.643 km	-1084.4 m/s			
GEM Event 15 (50 km)	298.164	≈ **49.772 km**		N/A	≈ 228 meters	0.195
Down Leg	298.2	59.639 km	-1168.48 m/s			

Program Enhancements

Airborne Bit Sync and PCM Decommutator

Issue

- Current user uplink command capability is limited to a single channel at 1200 baud communication rate

Expanded & Enhanced Capability

- NSROC has purchased new airborne bit sync/decom hardware that will allow up to 4 asynchronous channels (1 ACS command & 3 user channels) at baud rates totaling up to 200 K BPS maximum. ACS command rate is currently 1200 baud thus leaving considerable capability for the remaining 3 data channels.

Program Benefits

- This new capability will allow much greater Experimenter command uplink control of their instruments.

Status

- NSROC successfully flew this new hardware on 12.054.
- NSROC will fly this new hardware again in August on 12.056.

Program Enhancements

TV Video Digitization/Compression

Status

- The first flight unit and support GSE was shipped to WFF in early September, 2000 and integrated into 12.050 Terrier-Lynx TM system. Mission 12.050 flew on December 19, 2000 and successfully flight qualified this new hardware.
- This hardware has subsequently flown on 9 missions and is currently planned to fly on 4 future missions.

Issues

- Review of 36.197 flight data revealed the dim star field not viewable in uncompressed video. Investigation led to the realization that the Y-Brightness under the Luminance control needed to be set/adjusted with the TV camera subjected to the light level/s expected to be viewed in-flight.

Future Enhancements

- Post-flight software to convert compressed video to digital video standard CCIR-601/CCIR-656

Enhancement Benefits

- Would allow frame by frame processing of digital video data
- Would allow conversion to other digital video standards (AVI)

NSROC GNC

ACS Development Completed Flights

• NMACS Test 1	Krause 12.052	Aug 2003
• NMACS Test 2	Krause 12.053	Oct 2003
• NMACS 1st Op	Kintner 35.035	Jan 2004
• NMACS 2nd Op	Hysell 29.037	Jul 2004
• GLN-MAC Test 1	Feldman 36.208	Dec 2003
• ST-5000 Test 1	Harris 36.188	Dec 2001
• ST-5000 Test 2	Krause 12.054	April 2004
• NIACS Test 1	Krause 12.054	April 2004

ACS Development Planned Flights

• NIACS Test 2	Krause 12.056	Aug 2004
• NIACS 1st Op	Lynch 40.017	Feb 2005
• NIACS 2nd Op	Kletzing 35.036	Nov 2005
• NIACS 3rd Op	Earle 36.218	Mar 2006
• Celestial Test 1	Costello 12.058	Mar 2005
• Celestial Test 2	Costello 12.059	Jun 2005
• Celestial 1st Op	Nordsieck 36.173	Jul 2005
• Celestial 1st Op	Cruddace 36.207	Nov 2005

- NRACS – Micro-gravity - can do with either NMACS or NIACS

- Independent Reviews Will Be Conducted For ALL Test Rounds and First Operational Missions

NMACS

- NMACS Process Improvements
  - Upgraded and Expanded Procedures
  - NMACS Test Function Improvements
  - Field Phasing Test Capability of Complete Payload
  - Magnetic Air Bearing Test Facility Implemented at WFF
  - Mission Configuration and Phasing Controlled **100% in Software**
    - No Mission-Specific NMACS Drawings Required
    - Wiring never Changes
  - Magnetic Mission Now 100% Responsibility of NSROC-WFF

- NMACS Configuration Management
  - Drawings Controlled in ***Adept***
  - Procedures Controlled in ***Adept***
  - System Data Book Controlled in ***Adept***
  - Software Controlled in ***Visual Source Safe***

NMACS PROCESS FLOW

NMACS Process Flow – System Level

June 14, 2004

Pre-Integration Tests

1. System Component List – Mission-specific Wirelist
2. Mechanical Inspection – Mechanical Layout Drawing
3. Pneumatic Assembly Instructions – GN50266
4. Rate Sensor Acceptance – GN51169-GN51172
5. Battery Assembly and Test – EEPUB-0055
6. Electronics Stack Acceptance – GN51000
7. Pneumatics Acceptance – GN46827
8. HILTS Test – GN46826
9. Nozzle Size & Regulator Calculation – System Data Book
10. Air Bearing Test – GN51260

(Continued)

1. Power Console Checkout – GN51094
2. Auxiliary Power Box Acceptance – GN51095

Intergration & Field Tests

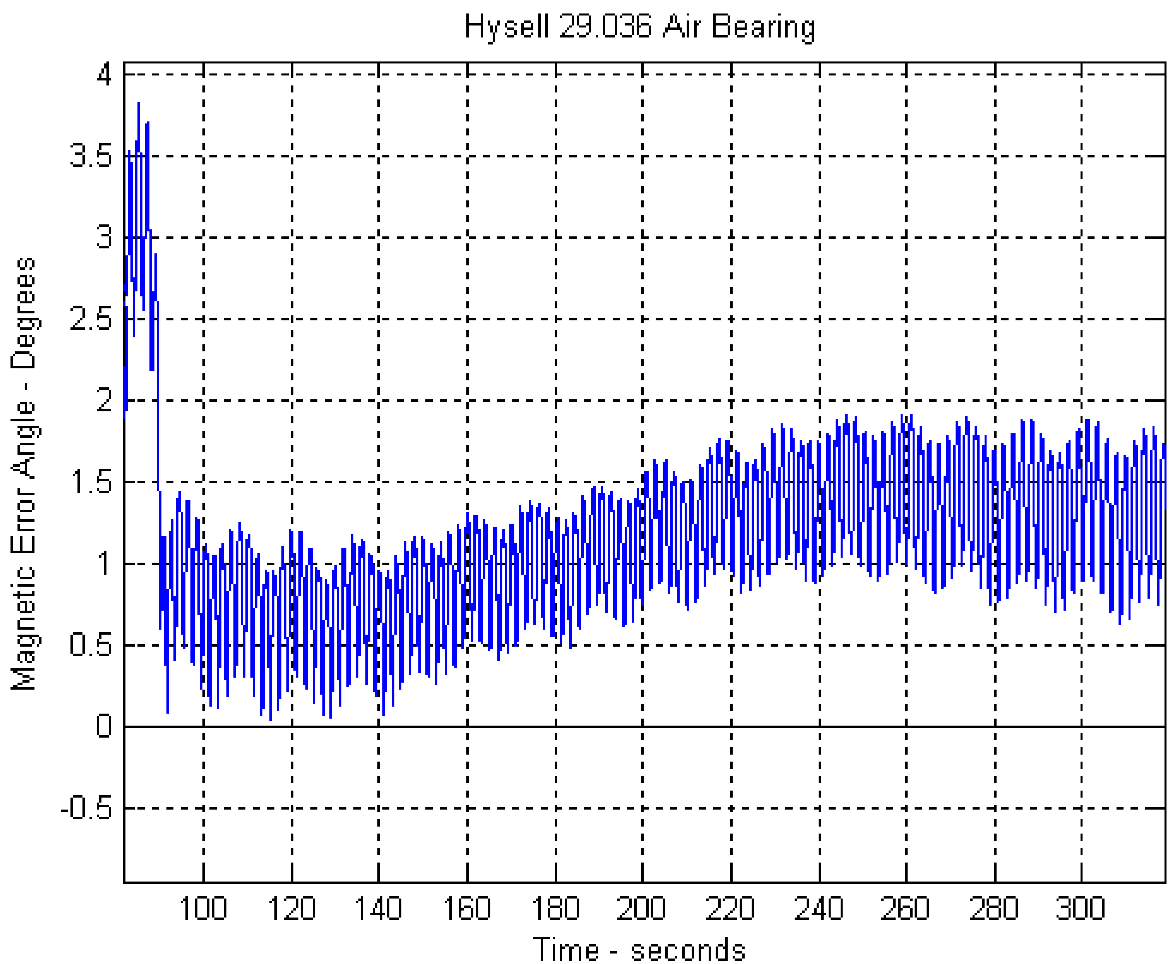
1. NMACS / TM Turn-On Test – GN48160
2. Pre-Vibe “All/No Fire” Sequence Test – GN48160
3. Vibration Test – GN48160
4. Post-Vibe “All/No Fire” Sequence Test – GN48160
5. Magnetometer Calibration – GN46838
6. HILTS Test – GN46826
7. Air Bearing Test – GN51260
8. Final Nozzle Size & Regulator Calculation – System Data Book
9. Umbilical and Landline Checks – GN50618-F00
10. PAGE - Boost Pump Test – WFF25-1-1
11. Pneumatics System Leak Test – GN48160
12. End-to-end Polarity Test – GN47078
13. Horizontal/Vertical - Rail Tests – Countdown
14. 3-hour - Rail Test – Countdown

NMACS IMPROVEMENTS

- NMACS Limitations
  - Fast Convergence and Fine Pointing/Low Coning Are Conflicting Objectives
  - Need To Allow For Magnetometer and/or Rate Sensor Noise and/or Bias
  - Noise and/or Bias Can Cause Excessive Nozzle Firing and Coning
  - We Have Adjusted Gain and Dead Band To Reliably Achieve Approximately One Degree Pointing Error And One Degree Cone
  - Need To Work With Experimenters To Mutually Understand Science Requirements Vs NMACS Performance Tradeoffs

- NMACS Potential For Improvement
  - Processor Upgrade – Memory, Speed, Communications
  - Software Improvements – Checksum, Error Checking, Bias Elimination
  - Evaluate Bi-Level Pitch Control
  - When Precise Attitude Data is Required, Use NIACS!
  - NSROC(a) Sun Sensor is Providing Adequate Attitude Data

Hysell 29.036 Air Bearing



NMACS Corrective Action

- CATS 4070: Unclear lines of responsibility (no system ownership).
  - AIB AI #1. Identify a cognizant NMACS Engineer for system ownership.
  - Corrective Action: NMACS is now 100% owned and operated (including all software and ground support equipment) by NSROC GNC at WFF. A cognizant NMACS engineer has been assigned. Complete.

NMACS Corrective Action

- CATS 4071: Inadequate understanding of NMACS system.
  - AIB AI #2: Establish a System Level Process Flow. Develop hardware checkout procedures/documentation. Develop detailed procedures for system checkout. (Including a phasing test for verifying polarity, etc. With flight sensors and flight software)
  - Corrective Action: All phases of the NMACS process are covered in new and expanded procedures. All NMACS drawings and procedures, and the system data notebook, are controlled in ***Adept.*** Software is controlled in ***Visual Source Safe.*** Magnetic Air Bearing is Operational at WFF. The software has been modified to support a complete phasing test of the ACS in the assembled payload in the field. GNC is rapidly gaining experience in building and testing NMACS. Complete.

NMACS Corrective Action

- CATS 4072: Not optimal software design/interface.
  - a) Lack of configuration control - Each flight currently requires newly compiled, modified flight code……. Use of modified software headers to track different flights/configurations.
  - b) Software/hardware interface - Current software/hardware interface scheme requires EEPROMs burnt for any change and for each mission. No read-back feature to ensure proper flight code in system (CHECKSUM).
  - AIB AI #3. A. Establish and maintain NMACS Configuration Control - A. Enhance the engineer's "system design document" to include: 1.Process flow & test plan 2.Configuration control of airbearing and flight (specifically noting differences (and understanding them)) 3.Software configuration control B. Enhance the tech's logbook to include, at a minimum: 1. Noting all NMACS hardware activities (pneumatics, interface tests, pressure tests, hardware mods/deltas, etc.) 2. Processing documents/ test plans

NMACS Corrective Action

- CATS 4072 (continued):
  - Corrective Actions:
  - a) IN PROGRESS. The code has been modified to make it simpler and more straightforward to enter mission specific code, but a table-driven mission timeline loaded from a file cannot be attempted until the processor is upgraded.
  - b) IN PROGRESS. Processors for upgrade are being evaluated. An engineer has been assigned to develop a checksum routine.
  - AI #3:A. Configuration Control has been established as outlined in Cats 4071. ACS System Data Book has been enhanced to include payload configuration drawing for air bearing and flight, specifically noting all sensor and software coordinate systems. Mission Configuration and Phasing are now controlled 100% in Software. No mission-specific NMACS drawings are required. Wiring never Changes. System logbook enhancements made per CATS 4073. COMPLETE

NMACS Corrective Action

- CATS 4073: Inadequate design/processing logbooks (engineer's and technician's).
  - AIB AI #4. Enhance the NMACS tech's logbook to include, at a minimum: a)Noting all NMACS hardware activities (pneumatics, interface tests, pressure tests, hardware mods/deltas, etc.) b)Processing documents/ test plans
  - Corrective Action: All NMACS procedures, when completed, are filed in the system notebook/logbook. Automated data capture and data reduction programs have been written which allow evaluation of the data in MatLab immediately upon completion of testing (HILTS, Sequence Testing, and Air Bearing). The data and mission-specific data reduction programs are filed in the GN directory of the relevant mission in the IMSS repository. Complete.

NMACS READINESS FOR KWAJ

- Hysell 29.036/037
  - Final Air Bearing Completed 6/14/04
  - Ready To Ship
- NASA Independent Review of NMACS 6/15/04
  - NSROC AIB Action Items
  - NASA AIB Action Items
  - Top-To Bottom NMACS Process Review
  - Readiness For Kwajalein
- Gelinas 27.145/146
  - Phasing Tests Completed 6/14/04
  - Final Air Bearing Still Needed
- Pfaff 21.132/133
  - Commencing TM Checks
  - Still Need NMACS Acceptance Air Bearing

SPINNING NIACS

- Spinning NIACS Development
  - Same Algorithm As NMACS (Hubert)
  - Applied to Four Pitch/Yaw Nozzles
  - Two Pitch/Yaw Nozzles Will Be Adequate For Some Missions
  - Single Axis (Vector) Target
  - Generally Geocentric Targets
    - Inertial Target Coordinate Frame Determined at T=0
    - Requires Known Delta-T from Initialization To Launch
    - For Lynch, Can Hold/Reinitialize With Acceptable Error
  - Earle Mission Requires Zero AOA
    - To Be Met With GPS Velocity Vector Input
  - Kletzing Magnetic Mission Requires Precise Attitude Data
    - To Be Met With Digital Magnetometer Input to NIACS

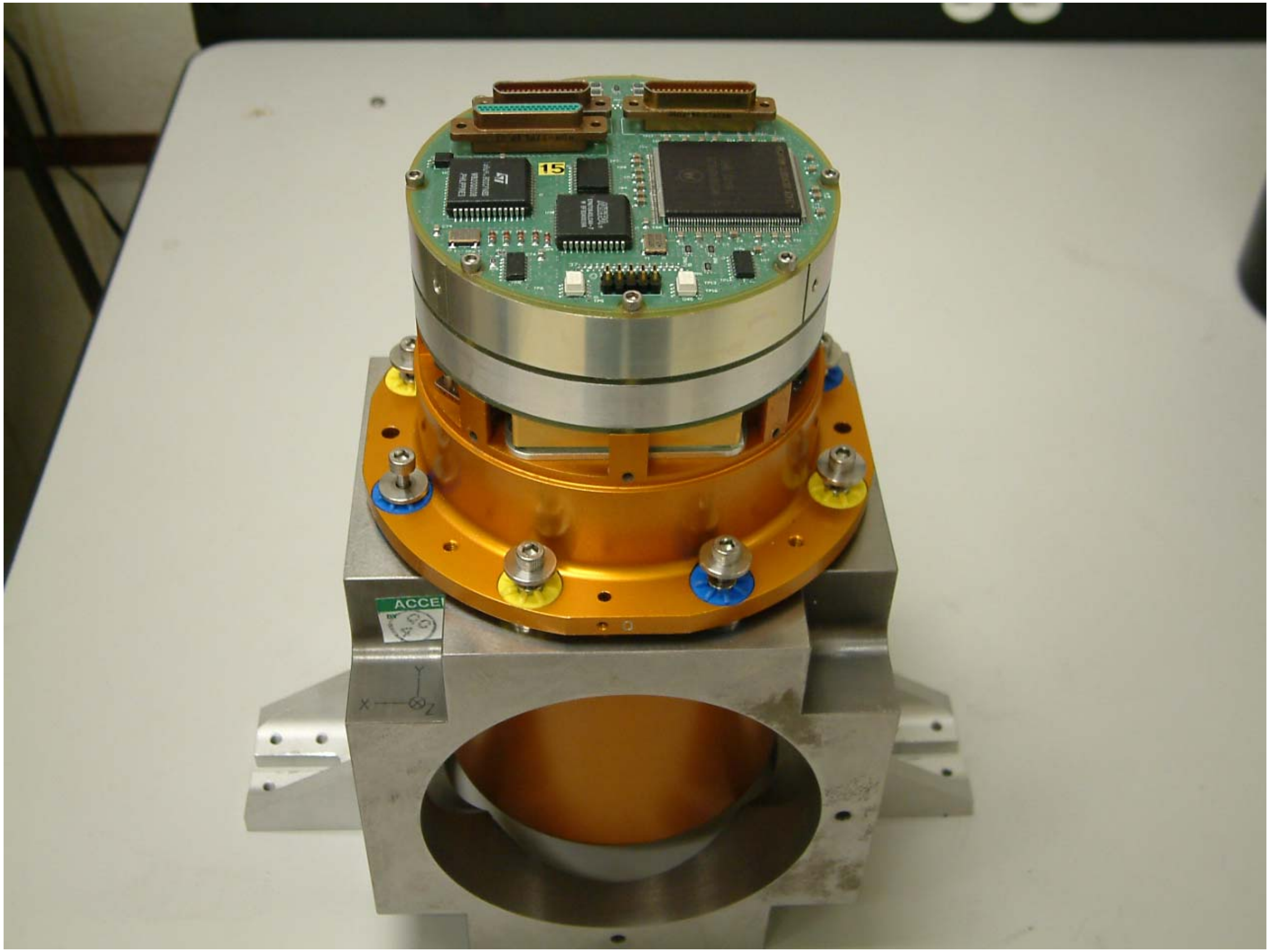
CELESTIAL NIACS

- Celestial NIACS Development
  - To support Cruddace 36.207 the Celestial ACS requires:
    - Initial pointing error after settling on target: < 2 arc min
    - Angular rates during pointing: < 1 arc sec / sec
    - Drift rate of TRIG platform: < 0.2 arc min / min
    - ACS command uplink performs pointing error corrections within 2 arc min.
  - These Pointing and Jitter Requirements are precise, but have been achieved by both AeroJet Mk VI-D and SPARCS VII
  - Evaluate candidate TRIGS
    - Current Kearfott mechanical TRIGS
    - Honeywell GG1320 Ring Laser Gyro.
  - Evaluate ST-5000 capability without TRIGS
    - On the air bearing
    - If satisfactory, evaluate in-flight (toward end of test mission)

GLN-MAC-200

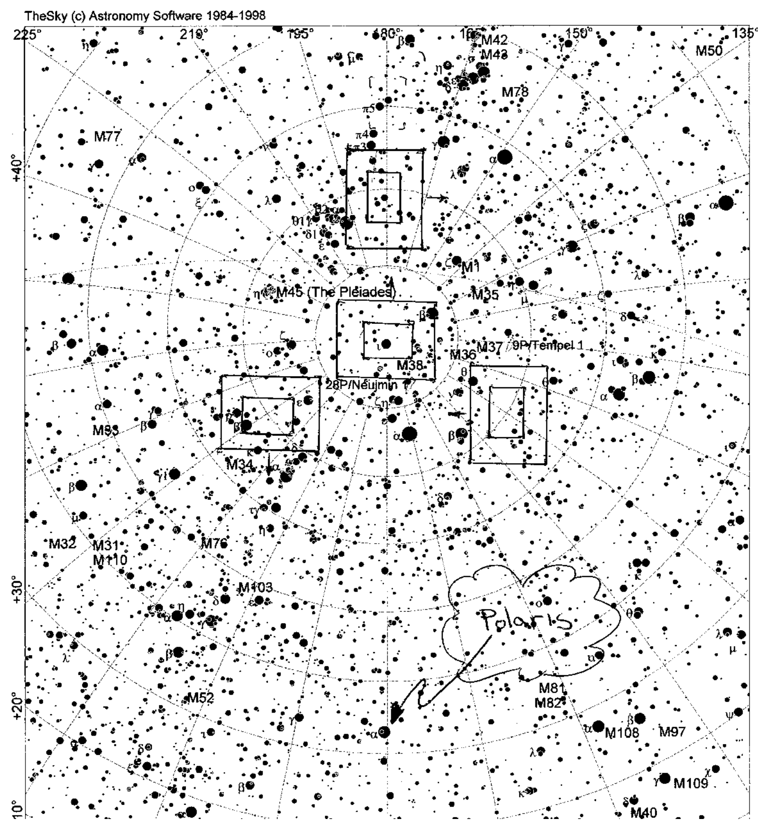
- GLN-MAC performance
  - Advertised 1 deg
  - Actual ~ 0.5 deg
  - List Price $60,000
  - Refurbishment Cost $2000
- Space Vector MIDAS performance
  - Advertised 3 deg
  - Actual 1.5 to 2 deg
  - List Price $70,832
  - Refurbishment $27,000 to $41,000

GLN-MAC-200

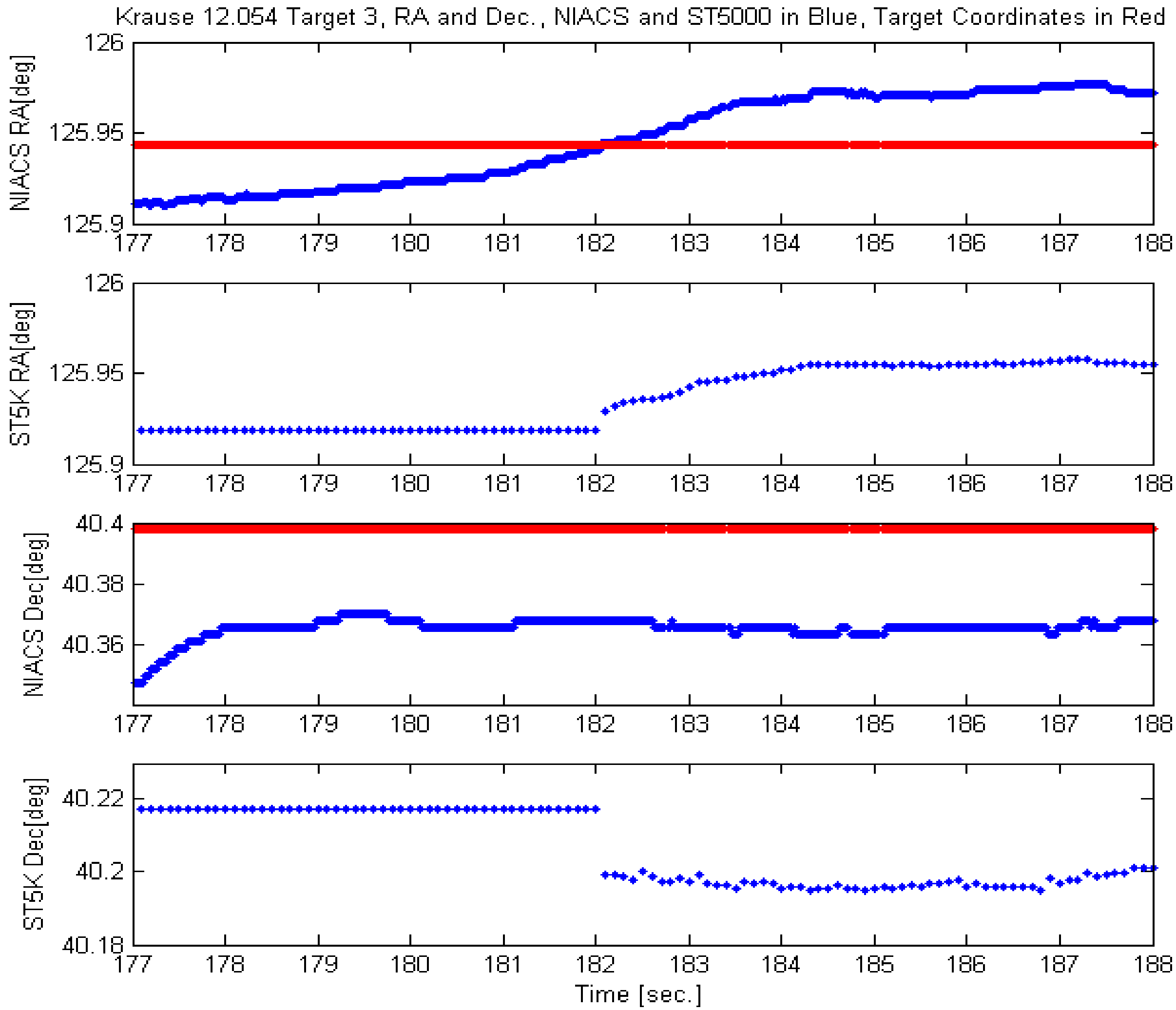


Krause 12.054 Inertial ACS

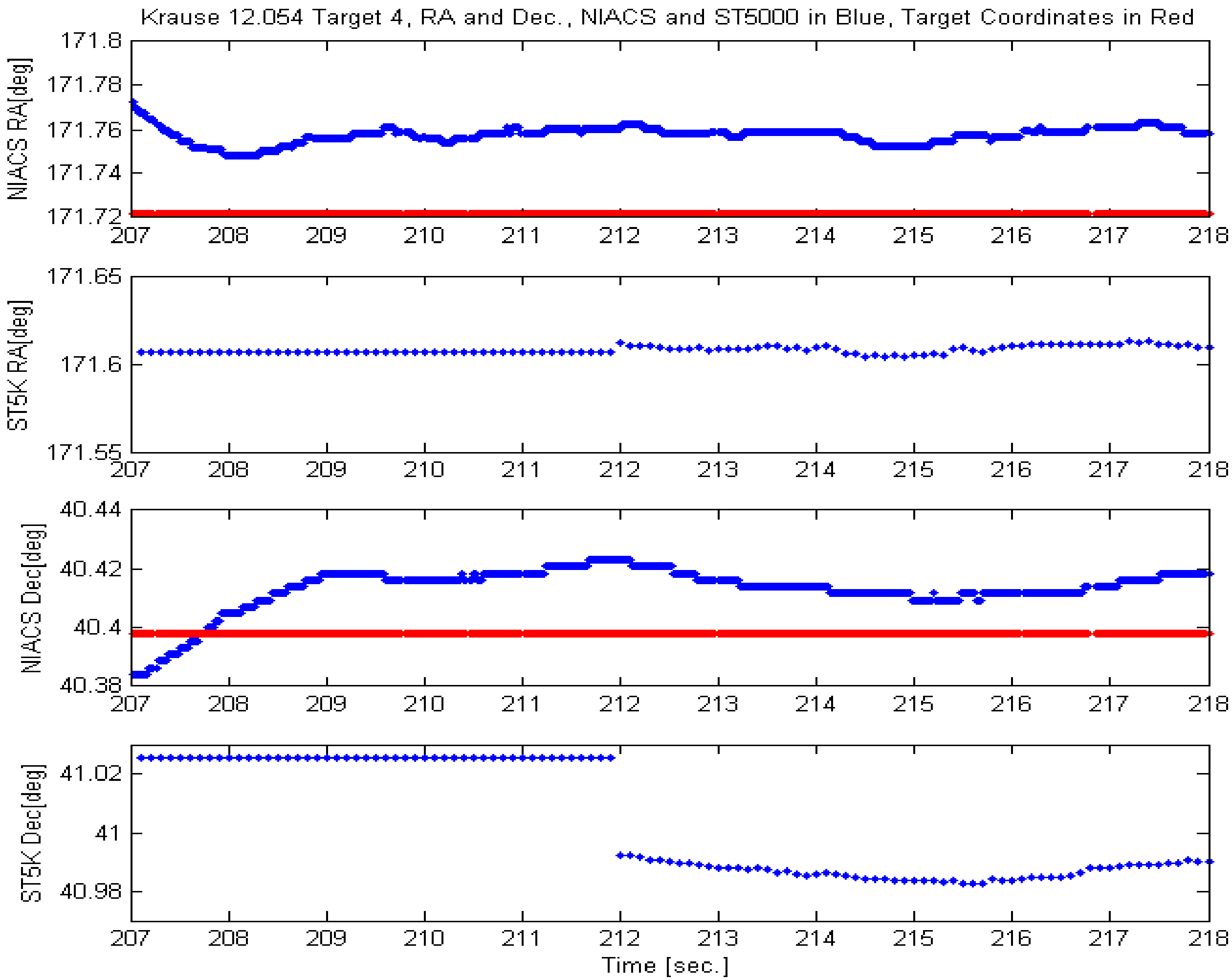
- NIACS/GLN-MAC
  & ST-5000 Performance
  - Absolute tracking error ~ 0.5 deg
    Mostly due to rail, alignment uncertainties
  - Relative tracking error ~ 4 arc-min
  - Measured Drift ~ 2.1 deg/hour



NIACS/GLN-MAC & ST-5000



NIACS/GLN-MAC & ST-5000



NSROC Mechanical

NSROC Mechanical

- Summary of Design Capability Enhancements
  - SolidWorks fully integrated as primary design and drafting software
  - SolidWorks also integrated with Adept document control database
    - Allows for control of standard components and design features libraries
    - Better control of design changes
  - Working with Machine shop to fully integrate SolidWorks with their CAM software.

Analytical Capability Enhancement

- Focus on Analysis Capability Enhancements
  - Intend to have all mechanical engineers trained in MSC/NASTRAN (FEA) by next SRWG
    - Static, Dynamic, Thermal
  - Currently evaluating kinematics software to analyze behavior of mechanisms
    - Booms, ejectable bodies, etc.
  - Vibration Loads
    - Several recent flights instrumented
    - Currently analyzing data
    - Goal is to define testing loads that more closely match flight environments

Conclusions

- NSROC Is Committed to Continuing the Mission and Program Successes
- Satisfying the Code S PI Mission Requirements Is Still NSROC's Primary Goal
- NSROC Is Committed in Expanding the Technical Innovations While
  - Maintaining a Cost Effective Environment
  - Meeting the Success Requirements of the PIs
  - Making Effective Use of the In-House Talent and Experience
- NSROC's Receipt of the SRWG Findings Is Important for Future Growth Planning